

CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH

WALTER M. DICKIE, M.D., Director

University of California

Weekly Bulletin



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 State Office Building, 217 West First  
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Entered as second-class matter February 21, 1922, at the post office at Sacramento, California, under the Act of August 24, 1912.  
 Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917.

Vol. XVII, No. 23

July 2, 1938

GUY P. JONES  
 EDITOR

# *The Carbon Monoxide Hazard in Traffic Accidents*

The Industrial Hygiene Service of the California State Department of Public Health, Dr. John P. Russell, Chief, has issued a preliminary report covering the carbon monoxide hazard in relation to California highway traffic casualties. Dr. Russell was assisted in making the survey of such hazards by Sergeant George S. Zelk, Bureau of Commercial Equipment, California Highway Patrol, and Fred R. Ingram, Senior Engineer, Industrial Hygiene Service, California State Department of Public Health.

In 1937, out of 37,968 traffic accidents on California highways, 597 were attributed officially to "sleepiness" of the drivers of the vehicles involved. It is admitted that fatigue due to long hours of driving and insufficient rest contributes to sleepiness and the theory that the inhalation of engine exhaust gases is responsible in part at least for otherwise inexplicable accidents, led to the making of the survey.

Determinations of carbon monoxide in drivers' compartments of motor vehicles were made in nine widely scattered areas of California. This work was conducted on ascending and descending grades, as well as on level highways, under varying weather conditions, including snow, rain and desert heat, at various hours of the day and night, in temperatures

ranging from 21 degrees to 74 degrees Fahrenheit, and relative humidities ranging from 18 per cent to 97 per cent.

Most of the vehicles tested were trucks and busses, for the reason that they all fall into the industrial hygiene classification. At a later time, under other auspices, similar tests on passenger cars may be undertaken.

A total of 1105 vehicles was tested in the survey, and in 2 per cent of the vehicles tested, the carbon monoxide concentration was found to be 100 parts per million or higher. Such a concentration of carbon monoxide is sufficient, in some cases, to cause headache, sleepiness and impaired judgment, when inhaled over a period of six to eight hours. In vehicles, where such high concentrations are found, potentially dangerous conditions exist, and it is essential that the source of the dangerously high concentration be discovered.

Generally, the defect was traced to one or more of the following defects in the exhaust system: loose exhaust pipe or manifold connection, blown-out exhaust gasket, cracked exhaust manifold, leaky muffler or faulty design of the exhaust system. Exhaust gases escaping from these defects may enter the driver's compartment in large quantities through openings in and around the cab without the driver



being aware of their presence. Correction of defects in the exhaust system greatly reduces the amount of carbon monoxide to which the driver is exposed.

In an effort to correlate the effects of inhalation of engine exhaust gases with the ability to drive motor vehicles, five volunteers, including the writers, underwent a series of tests of their steering ability, perception and reaction time, eye-hand and eye-foot coordination, visual acuity, field of vision, depth perception, speed estimation, color vision and glare resistance, before and after the inhalation of known amounts of carbon monoxide during a four-day period.

These tests were made with the cooperation of the Division of Drivers' Licenses, State Department of Motor Vehicles, using instruments and apparatus assembled by them for measuring driving skill. The subjects were first given a series of tests on the instruments to reduce the learning or practice factor. Blood pressure and pulse readings were taken, and determinations of blood saturation with carbon monoxide by the pyrotannic acid method were made. The subjects then spent one hour in an improvised gas chamber, a closed sedan into which engine exhaust gas was introduced by means of a hose from the exhaust pipe. The concentration of carbon monoxide in the chamber, determined by the two carbon monoxide indicators used in the survey, was kept constant by admitting small amounts of exhaust gas from time to time to replace that which leaked out gradually. At the end of the period of exposure, blood samples were again tested, and driving tests were repeated. It was found that exposure to the gas had very little effect on blood pressure, pulse rate, steering ability, visual acuity, field of vision, color vision, depth perception, speed estimation or glare resistance.

The blood saturation readings are not considered reliable, due to inaccuracies in color standards which were not discovered until after the tests were made. However, they suggest that carbon monoxide when inhaled in small amounts day after day has a cumulative effect, and is not completely eliminated from the body in a few hours after exposure, as is commonly believed. Further tests along this line have been planned for the near future.

Braking time represents the interval, in hundredths of a second, elapsing between the appearance of a red light and the application of the brake by the subject, seated behind a set of standard automobile controls, following a moving road scene by manipulating the steering wheel. It was found that the inhalation of an amount of carbon monoxide

considered equivalent to that breathed by the driver of a vehicle containing 100 parts per million of the gas during a six to nine hour driving period, caused a diminution in driving ability as indicated by headache, muscular weakness and tremors, mental confusion, and a small but definite lengthening of braking time. It is believed that this effect is greatly increased by fatigue such as is experienced by drivers of motor vehicles, particularly heavy trucks or similar vehicles. Plans are being made to conduct further tests under conditions more closely approximating actual driving conditions in order to minimize the learning factor and to include the fatigue factor in combination with exposure to carbon monoxide.

Following are the conclusions reached by Dr. Russell as a result of this preliminary survey:

It is believed that many otherwise unexplained highway accidents, in which experienced drivers, traveling along a straight highway in broad daylight after a good night's rest, run off the road or crash head-on into an approaching vehicle, are due to the driver unknowingly breathing dangerous amounts of exhaust gases escaping from defects in the exhaust system of the vehicle he is operating.

In the absence of defects in the exhaust system, it is believed that there is little danger of carbon monoxide poisoning from engine exhaust gases while driving along the highway.

The exhaust systems of motor vehicles should be inspected carefully, and periodically, for any defects which permit the escape of exhaust gases before reaching the exhaust pipe outlet.

Such defects should be corrected immediately to protect the driver from exposure to dangerous concentrations of carbon monoxide in the escaping gases.

Drivers' compartments of motor vehicles should be fitted with tight floor mats to exclude exhaust gases which may enter through cracks around floor boards. Openings in the dash should be closed as tightly as possible.

#### DR. ZINNAMON AT SONOMA

Dr. B. L. Zinnamon has been appointed health officer of Sonoma County under the newly organized full-time health unit plan, effective July 1, 1938.

Dr. F. E. Sohler, Jr., has succeeded Dr. D. C. Oakleaf as city health officer of Cloverdale.

"National hygiene and preventive measures can rid mankind of disease."—Metchnikoff.



**MATERNAL MORTALITY**

There were 392 maternal deaths recorded in California last year as compared with 401 such deaths in 1936, the rates for the years being, respectively, 4.1 and 4.7. Rates lower than for the state as a whole were recorded chiefly in the larger centers of population—Alameda, Los Angeles, San Diego, and Sacramento counties. Higher rates than the state rate were common in the counties of smaller populations. Some of the rural counties had exceptionally high maternal mortality rates last year. Very often complicated and difficult cases occur in the rural districts where proper facilities for care in emergencies are entirely lacking.

The California maternal mortality rate for the white race was 3.9 as compared with the state rate for all races of 4.1. There were 57 Mexican maternal deaths in 1937 and the Mexican maternal mortality rate was 4.7. Almost 15 per cent of all maternal deaths in California last year were among Mexican mothers. The attached tables provide data on maternal mortality by counties and by races for the years 1936 and 1937.

**MATERNAL MORTALITY, 1937, 1936****By Counties**

	1937		1936	
	No.	Rate	No.	Rate
CALIFORNIA	392	4.1	401	4.7
Alameda	23	3.3	31	5.2
Alpine	---	---	---	---
Amador	---	---	1	15.1
Butte	6	8.5	3	4.9
Calaveras	---	---	---	---
Colusa	1	6.1	1	6.1
Contra Costa	6	5.4	7	7.4
Del Norte	1	14.1	---	---
El Dorado	---	---	1	6.6
Fresno	17	5.9	8	3.1
Glenn	1	6.3	1	7.6
Humboldt	10	14.2	3	4.4
Imperial	6	4.2	4	3.0
Inyo	---	---	1	11.4
Kern	9	3.6	15	7.6
Kings	4	6.0	3	5.2
Lake	---	---	---	---
Lassen	3	9.4	1	4.0
Los Angeles	127	3.5	152	4.7
Madera	2	4.1	1	3.1
Marin	3	8.4	---	---
Mariposa	1	33.3	---	---
Mendocino	3	8.3	---	---
Merced	4	4.7	4	5.8
Modoc	4	43.9	---	---
Mono	---	---	---	---
Monterey	3	2.9	9	9.6
Napa	---	---	1	3.5
Nevada	3	10.5	1	4.1
Orange	5	2.4	8	4.1
Placer	3	10.1	1	3.9
Plumas	---	---	1	7.7
Riverside	5	2.8	8	4.8
Sacramento	6	2.4	12	5.4
San Benito	---	---	---	---
San Bernardino	16	6.0	13	5.0
San Diego	14	3.3	21	5.4
San Francisco	33	4.0	18	2.5

	1937		1936	
	No.	Rate	No.	Rate
San Joaquin	8	4.3	11	6.7
San Luis Obispo	---	---	---	---
San Mateo	3	4.6	3	5.3
Santa Barbara	5	4.4	3	2.7
Santa Clara	12	5.0	10	4.7
Santa Cruz	5	8.6	5	9.1
Shasta	---	---	2	7.1
Sierra	---	---	---	---
Siskiyou	3	7.8	3	8.1
Solano	4	8.5	1	2.3
Sonoma	5	6.7	5	6.7
Stanislaus	6	4.7	4	3.6
Sutter	2	6.9	---	---
Tehama	1	3.7	4	18.8
Trinity	---	---	1	25.0
Tulare	6	3.2	9	5.4
Tuolumne	1	7.0	---	---
Ventura	8	6.8	8	7.1
Yolo	2	5.8	2	6.4
Yuba	2	8.1	---	---

**SALE OF CERTAIN RODENTS RESTRICTED**

Because chipmunks, golden mantled squirrels, and other rodents have been found to suffer from plague, the California State Board of Public Health has imposed restrictions upon the sale of such rodents as indicated in the following resolution of the board, issued August 17, 1937. The general public is advised not to handle such rodents, and dealers are warned that the requirements of this order must be observed:

WHEREAS, It has been determined that plague infection has been found to exist in chipmunks in certain areas in California and other western states, and furthermore, it has been determined that this infection may be transmitted to man, and

WHEREAS, It has become urgent to take all necessary precautions to prevent the transmission of plague infection to human beings as well as to protect this state in its sanitary relation with other states and countries;

Therefore, be it ordered, under the authority vested in the Director of Public Health by Sections 2979 and 2979a of the Political Code of California, and the Public Health Act of this state, as amended, that the shipment or sale of chipmunks and/or golden mantled squirrels or other wild rodents be prohibited unless said chipmunks or golden mantled squirrels or other wild rodents are held in quarantine for a period of two weeks prior to date of shipment or sale, in either domestic or foreign trade. During this period of quarantine said animals are to be maintained in individual cages and any animal dying during the period of observation shall not be destroyed but shall be reported at once to the local health officer. The health officer shall thereupon communicate with the State Department of Public Health for instructions regarding the shipment of the animal to the state laboratory for examination. If any chipmunks and/or golden mantled squirrels or other wild rodents have been trapped in the same general area in which an animal has been found to be plague-infected, the entire consignment shall be destroyed.



## MORBIDITY

Complete Reports for Following Diseases for Week Ending  
June 25, 1938

## Chickenpox

341 cases: Alameda County 7, Alameda 3, Albany 8, Berkeley 4, Oakland 25, Contra Costa County 4, Pittsburg 2, Richmond 5, Fresno County 1, Fresno 3, Kern County 4, Los Angeles County 41, Alhambra 6, Glendale 7, Huntington Park 1, Long Beach 6, Los Angeles 49, Monrovia 1, Pasadena 3, Pomona 1, Santa Monica 2, Lynwood 2, South Gate 1, Monterey Park 5, Gardena 1, Madera 1, Sausalito 1, Gustine 1, King City 1, Grass Valley 1, Orange County 2, Newport Beach 3, Santa Ana 2, La Habra 6, Riverside County 1, Banning 19, Corona 1, Riverside 1, Sacramento 4, Ontario 1, Redlands 1, San Bernardino 1, San Diego County 5, Coronado 1, San Diego 10, San Francisco 34, San Joaquin County 11, Stockton 9, San Luis Obispo 1, Santa Barbara 11, Santa Maria 8, San Jose 2, Santa Cruz 2, Sonoma County 4, Tulare County 1, Ventura 1, Woodland 2.

## Diphtheria

26 cases: Oakland 4, Fresno County 1, Humboldt County 1, Los Angeles County 2, Burbank 1, Los Angeles 13, San Francisco 1, San Joaquin County 1, Santa Barbara 1, Sunnyvale 1.

## German Measles

26 cases: Alameda 2, Kern County 2, Long Beach 1, Los Angeles 7, South Gate 1, Maywood 1, Bell 2, Sausalito 1, Orange County 1, Riverside County 2, San Diego 1, San Francisco 1, San Mateo County 2, Palo Alto 1, Sonoma County 1.

## Influenza

11 cases: Oakland 1, Los Angeles County 2, Los Angeles 7, Gardena 1.

## Measles

549 cases: Oakland 12, Chico 2, Contra Costa County 1, El Dorado County 1, Fresno County 3, Fresno 2, Kern County 28, Bakersfield 3, Hanford 9, Los Angeles County 29, Burbank 1, Claremont 1, Culver City 6, Glendale 9, Huntington Park 2, La Verne 1, Long Beach 11, Los Angeles 58, Pasadena 3, Pomona 1, Monterey Park 1, Bell 5, Madera County 13, Madera 5, Sausalito 1, Monterey County 3, Salinas 1, Orange County 12, Anaheim 1, Brea 8, Newport Beach 11, Orange 12, Santa Ana 23, Laguna Beach 7, Pacentia 4, San Clemente 1, Riverside County 2, Banning 2, Riverside 2, Sacramento 34, Redlands 25, San Bernardino 3, San Diego County 17, Coronado 2, National City 2, San Diego 76, San Francisco 3, San Joaquin County 4, Lodi 2, Manteca 1, Stockton 3, San Luis Obispo County 4, San Luis Obispo 12, San Mateo County 7, Santa Barbara County 5, Santa Barbara 1, Santa Maria 9, Santa Cruz County 1, Turlock 1, Sutter County 2, Tulare County 3, Porterville 1, Tuolumne County 1, Ventura County 4, Fillmore 2, Ventura 6, Ojai 1, Yolo County 13, Davis 2, Woodland 2, Marysville 2, California 1.\*

## Mumps

262 cases: Alameda County 6, Alameda 9, Berkeley 2, Oakland 46, San Leandro 2, Contra Costa County 4, Fresno County 6, Fresno 1, Bakersfield 2, Hanford 1, Lake County 3, Los Angeles County 19, Alhambra 4, Compton 2, Hermosa 1, Huntington Park 3, Long Beach 5, Los Angeles 35, Santa Monica 3, Torrance 2, South Gate 1, Maywood 1, Bell 1, Madera County 4, Sausalito 1, Gustine 1, Orange County 11, Anaheim 1, Newport Beach 1, Santa Ana 2, Riverside County 1, Corona 1, Sacramento 20, Redlands 1, San Diego County 5, San Diego 11, San Francisco 17, San Joaquin County 5, Santa Barbara County 1, Santa Barbara 5, Santa Clara County 3, San Jose 8, Solano County 1, Tulare County 1, Lindsay 2.

## Pneumonia (Lobar)

35 cases: Fresno 1, Los Angeles County 3, Los Angeles 11, South Gate 1, Orange County 1, Newport Beach 1, Banning 1, Sacramento County 6, Sacramento 3, San Bernardino 1, San Diego 1, San Francisco 2, San Luis Obispo County 1, San Mateo County 1, Yolo County 1.

## Scarlet Fever

118 cases: Alameda County 2, Alameda 2, Albany 1, Berkeley 2, Fresno County 2, Humboldt County 1, Kern County 8, Bakersfield 1, Hanford 3, Los Angeles County 15, Arcadia 1, Burbank 1, Glendale 2, Long Beach 3, Los Angeles 27, Monrovia 1, Pasadena 1, Redondo 3, San Gabriel 2, Santa Monica 3, Torrance 1, Lynwood 1, South Gate 1, Monterey Park 1, Bell 1, Santa Ana 6, Sacramento 2, Ontario 1, San Bernardino 1, San Diego 3, San Francisco 4, Stockton 1, Tracy 1, Santa Maria 2, Santa Clara County 3, Santa Cruz 1, Yreka 1, Sonoma County 3, Santa Rosa 2, Lindsay 1.

## Smallpox

8 cases: Fresno County 1, Kern County 3, Hanford 1, Los Angeles 1, Monterey County 1, Visalia 1.

## Typhoid Fever

5 cases: Albany 1, Richmond 1, Kern County 1, Orange County 1, California 1.\*

## Whooping Cough

281 cases: Alameda County 34, Alameda 12, Albany 2, Berkeley 3, Livermore 3, Oakland 21, San Leandro 4, El Dorado County 1, Fresno County 2, Fresno 3, Los Angeles County 20, Alhambra 6, Compton 2, Huntington Park 1, Long Beach 6, Los Angeles 23, Pasadena 3, South Gate 2, Madera County 1, Sausalito 1, Gustine 5, Monterey County 1, Grass Valley 5, Orange County 3, Santa Ana 4, Corona 7, Riverside 5, Sacramento 7, San Diego County 2, San Diego 18, San Francisco 22, San Joaquin County 5, Lodi 2, Stockton 16, Tracy 2, San Mateo County 1, San Carlos 1, Santa Barbara County 2, Santa Clara County 6, Gilroy 1, Palo Alto 5, San Jose 2, Suisun 1, Ventura County 4, Santa Paula 1, Ventura 2, Woodland 1.

## Meningitis (Epidemic)

One case: Tulare County.

## Dysentery (Amoebic)

5 cases: San Diego County 2, San Diego 1, Arroyo Grande 1, Ventura 1.

## Dysentery (Bacillary)

5 cases: Los Angeles County 1, Los Angeles 1, San Francisco 2, San Mateo County 1.

## Poliomyelitis

2 cases: Kern County 1, Los Angeles 1.

## Trachoma

12 cases: Madera 1, Riverside County 9, Tulare County 2.

## Jaundice (Epidemic)

One case: Placerville.

## Food Poisoning

37 cases: Fresno County 4, San Francisco 2, Paso Robles 2, Menlo Park 1, Palo Alto 28.

## Undulant Fever

9 cases: Contra Costa County 1, Los Angeles 1, Montebello 1, Ontario 3, San Diego 1, San Luis Obispo 1, Santa Barbara County 1.

## Coccidioides Granuloma

One case: Los Angeles.

## Septic Sore Throat

2 cases: Kern County 1, Sonoma County 1.

## Rabies (Animal)

28 cases: Fresno County 4, Bakersfield 1, Los Angeles County 6, Alhambra 1, Los Angeles 3, Pasadena 1, Pomona 1, Vernon 1, Santa Clara County 7, Mountain View 1, Santa Clara 1, Sunnyvale 1.

\* Cases charged to "California" represent patients ill before entering the state or those who contracted their illness traveling about the state throughout the incubation period of the disease. These cases are not chargeable to any one locality.

The required methods of work are no secret; for they have been employed by thinking individuals ever since the time of Socrates. Here one can not build without laying foundations. One can not, for example, be a radio expert without the principles of electricity. One can not be a business expert without economics. One can not be an engineer without getting a knowledge of mathematics. Thus it runs throughout the cycle of subjects. Successful work is a kind of development; so before going far one must master its preliminary and prerequisite stages. There is no other valid way. One can not build a tower without first laying a solid foundation.

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